

AGENCY FOR INTERNATIONAL DEVELOPMENT WASHINGTON, D. C. 20523 <b>BIBLIOGRAPHIC INPUT SHEET</b>		<b>FOR AID USE ONLY</b> Batch 39
1. SUBJECT CLASSIFICATION	A. PRIMARY	TEMPORARY
	B. SECONDARY	
2. TITLE AND SUBTITLE Multinational corporations and adaptive research for developing countries		
3. AUTHOR(S) Margolies, D.F.		
4. DOCUMENT DATE 1972	5. NUMBER OF PAGES 18p.	6. ARC NUMBER ARC
7. REFERENCE ORGANIZATION NAME AND ADDRESS AID/TA/OST		
8. SUPPLEMENTARY NOTES (Sponsoring Organization, Publishers, Availability) (Presented at Sym. on Priorities on Innovating and Adapting Technologies, Princeton Univ., 1972)		
9. ABSTRACT		

(Sci. & Tech--General R&D)

10. CONTROL NUMBER PN-AAC-408	11. PRICE OF DOCUMENT
12. DESCRIPTORS	13. PROJECT NUMBER
	14. CONTRACT NUMBER
	AID/TA/OST 15. TYPE OF DOCUMENT

ADAPTIVE  
PA-420-908

MULTINATIONAL CORPORATIONS AND  
ADAPTIVE RESEARCH FOR DEVELOPING COUNTRIES

BY

D. F. Margolies

1972

## MULTINATIONAL CORPORATIONS AND ADAPTIVE RESEARCH FOR DEVELOPING COUNTRIES

### Technological Transfer and Industrial Research

Until recently, attention of the development community has been focused on the commercial and financial aspects of technological transfer from the advanced countries to the developing countries. Considerable ingenuity has been devoted to the development of fiscal and monetary policies that create a climate which attracts foreign private investment and stimulates industrial growth. The choice of industrial technologies has been left to the private sector. It was assumed that the normal operation of market forces would determine the selection of technologies that can operate efficiently in the developing country environment.

For a variety of reasons, these policies and assumptions have now been challenged. Experience has shown that policies that are tilted in favor of capital investment in industry to the disadvantage of agriculture have frequently had unfavorable economic and social consequences. Thus, the emphasis on import-substitution industries in some countries has fostered, through over-protection, an unhealthy growth of high-cost inefficient industrial plants. Nor does industrial expansion per se create a corresponding increase in employment. An industry exempt from competition can rely on high-cost capital-intensive labor-saving equipment, with the result that its contribution to increased job opportunities is disappointingly modest. Moreover, to the extent that such industries displace local labor-intensive enterprises they further aggravate the unemployment problem.

As a consequence, attention is now turning toward the problem of a better selection of industrial technologies appropriate to the human and natural resources, as well as the capital investment capabilities, of the developing countries. There is also concern over the need for adaptive research to orient industrial technologies developed in the advanced countries to meet their requirements toward the particular requirements of the developing countries. The use of the term, adaptive research, in this connection has led to

some misunderstanding. To many adaptive research means simple adaptive engineering as applied to the different stages of the production process or to product design. Others are referring to the ability on the part of the developing countries to select among alternative technologies that which is best suited to a particular environment, or to blend technologies from different sources for that purpose, or to apply adaptive engineering to modify a given package of technology better to meet a given requirement. These activities may well require high professional training and sophisticated skills, but they do not necessarily correspond to the term industrial research as customarily used. For purposes of this presentation, however, the term adaptive research will be used to include adaptive engineering and discriminating selection of technology as well as innovative research for new industrial processes or new industrial products.

With the new recognition of the importance of adaptive research, broadly defined, there is increasing interest in the role of the multinational corporations. They have broad experience and unique talents in the industrial research area. This presentation is addressed to their interests in application of research to problems relevant to the developing countries and in increasing the capabilities of the developing countries to carry on such research on their own behalf.

#### Current Studies of Multinational Corporations

A number of studies of multinational corporations have been made and many others are in progress. Most of these are devoted to the role of multinational corporations in shaping international finance and international trade.<sup>1/</sup> But some of the recent efforts are pointed more sharply towards development. One of the resolutions adopted by the recent United Nations Conference on Trade and Development (UNCTAD) held at Santiago last spring called for a study, which is now in progress under the direction of the U.N. Secretary-General, of the role of multinational corporations

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<sup>1/</sup> See, for example, S. S. Katz, "The Multinational Corporation". Studies in U.S. Foreign Investment. Department of Commerce March 1972/3, Vols. 1-3.

with reference to their impact on the process of development, especially of the developing countries, and their implications for international relations. The Council of Americas recently completed a survey on the "Impact of Private Foreign Investment on Latin America's Scientific and Technological Progress". Under grants from several foundations and industrial organizations, the Graduate School of Business of New York University is conducting a broad study of multinational corporations, including aspects of their relations with the developing countries.

The National Academy of Sciences and the National Academy of Engineering have undertaken a study, financed by the Agency for International Development, on the role of multinational corporations in supporting research for developing countries. This study, carried out by a group of panels concerned with the industrial sectors of electronics, pharmaceuticals, food technology, chemicals and automotive and earth-moving equipment, has not been completed; but when available, it will present the expert views of leading industrialists, economists, scientists, and engineers on the interaction of the activities of multinational corporations and the technological infrastructures of developing countries.

This presentation describes activities of United States multinational corporations, using information in the published literature supplemented by discussions with a wide variety of knowledgeable individuals. Multinational corporations headquartered in countries outside the United States, such as the Philips Corporation of The Netherlands, are known to have developed imaginative programs in this area. However, detailed information on their activities is not readily available, and therefore the discussion does not include such activities.

#### Preinvestment for Research

The role of the multinational corporations in raising the general level of technical competence and of managerial skills in the countries where they operate is indeed impressive. This has been accomplished by extensive in-house training programs for employees and their families, by cooperative programs with Governmental and private educational institutions,

and by philanthropic contributions to local foundations devoted to advancing skills in science, technology and management. The report of the Council of Americas referred to above cites a long list of specific examples of training programs, educational programs, and philanthropic projects by a representative sample of leading multinational corporations operating in Latin America. The report shows that as of the end of 1966, 37,000 Latin Americans held management positions in U.S.-owned companies in Latin America, and 90,000 were in professional or technical employment categories. Since that time, the process of training employees to replace expatriate professional and supervisory personnel has been stepped up, and the figures today would undoubtedly be far larger.

The role of the corporations in providing a wide range of courses in management and in scientific areas is particularly noteworthy. Some of the training is accomplished in the United States. Many of the courses are offered in-house within the plant. In addition, arrangements are made with local universities for curriculum and institutional development, for lecturers for special courses, and for practical training experience for students and teachers within the plant on a part-time basis.

Many of those trained by American corporations have moved away to take employment with other industries and have carried their training and experience with them. The report observes that one-third of the Brazilians who received advanced training by the General Motors Corporation have taken positions in Brazil with other automobile companies or other industries.

A number of corporations have set up foundations to support education and research. The Creole Foundation, established by a subsidiary of Standard Oil of New Jersey in Venezuela, has a long and impressive record in supporting economic development in that country. The Gillette Foundation in Argentina has been concerned with "the brain drain" in that country and has contributed in a tangible way to bringing back talented Argentine scientists and engineers working abroad to assignments in Argentina. The Fund for Overseas Grants and Research in Education, known by its acronym FORGE, has received support from a number of corporations as well as the Ford Foundation and others

in the United States, and has conducted a valuable program in support of scientific research in Latin America. In short, there is no question that the multinational corporations have exerted a powerful influence within the countries where they operate for upgrading the quality of managerial and technical performance.

In some cases, the Governments of the developing countries have worked out cooperative arrangements to avail themselves of the talents offered by the presence of the corporation. This has undoubtedly accelerated the process of technological diffusion which otherwise might take place more slowly. For example, when the Singer Company approached the Government in Taiwan in the 1960's about locating a plant to manufacture a low-cost sewing machine for the East Asian market, the Government negotiated an arrangement calling for the Singer Company to upgrade the quality of the small family-run establishments in Taiwan which manufactured replacement parts and accessories for sewing machines. The arrangement worked out well to the mutual advantage of the company and of the local enterprises. As a result the location of the plant did not displace the local shops but raised the general level of competence.

#### Adaptive Engineering in the Processing Stage

The establishment of a manufacturing plant in a developing country involves a large number of engineering problems resulting from the new environment. A routine application of a well-established process in a technologically advanced country becomes an exercise in experimental development in a developing country. Apart from differences in the climate which may affect the manufacturing process and the lubricants and fuels which are employed, there is the lack of normal supporting services which are part of the infrastructure of the developed countries. In addition, the scale of the operation is likely to be smaller than typical plants in the developed countries involving a redesign of the entire plant.

In countries with a highly undeveloped technological infrastructure, the manufacturing process may be limited to a simple assembly of parts brought in from abroad. If a more complex manufacturing plant is established, there is greater scope for adaptive

research. Ideally, the plant should be designed to optimize the relationship between technology and local factor endowments, including the abundant supply of unskilled labor which is typically available in a developing country. In particular, there are obvious opportunities to substitute labor for capital investment in the pre-processing stage involving the inward movement and handling of material inputs and in the post-processing stage involving the packaging and outward movement of the final product. There is very little evidence available on the extent to which multinational corporations have been innovative in this area.

An interesting study by Howard Pack of a group of industries in Kenya suggests that technical know-how may play an important role independently of overall economic policy. He found that plants operated by multinational corporations in Kenya do adopt ingenious capital-saving practices, with some exceptions, whereas plants operated by local entrepreneurs whose background is commercial rather than technical often overlook these opportunities. The explanation appears to be that the owner of the locally owned plant has through lack of technical expertise allowed himself to be sold unnecessarily expensive capital-intensive equipment by engineering firms with a vested interest in selling as much equipment as possible. The multinational corporation with its greater experience with production in developing countries is on the lookout for inexpensive equipment. With its familiarity with sources of supply, it is in a position to locate and to purchase such equipment. Furthermore, the manager of the plant owned by the multinational corporation has the technical training and experience, plus the experience shared within the organization, so that he is able to organize production in such a way as to optimize the use of low-cost labor. On the other hand, Mr. Pack also found an efficient locally owned plant where the local manager had received his engineering training abroad.

Mr. Pack's conclusions are two-fold. In the first place he found no evidence in those industries he studied to support an oft-repeated assumption that multinational corporations have a propensity to purchase the same high-cost capital-intensive equipment for use in their plants in developing countries as they use in

their plants at home. In the second place, there is scope for adaptive engineering in certain stages which would optimize the use of the manufacturing process favorable to local endowments.<sup>1/</sup>

Governmental policy obviously plays an important role. If the plant is to produce for a sheltered domestic market, and if the product can be sold at whatever price is needed to bring in a profit, there is little incentive on the part of the producer to design the plant to operate efficiently and economically. On the other hand, if the product is to be exported and is to meet the competition of world trade, there is a great incentive to cut costs and to operate the plant at maximum efficiency. It is for this reason that an export-oriented industrialization policy is likely to develop a healthier industrial base than policies aimed at import substitution.

Governmental policy also contributes to multinational corporations moving into materials research and into quality control. Many countries which pursue an import substitution policy set requirements for a progressively larger amount of the components of the product to be derived from local sources over fixed periods of time. The multinational corporation is thus required to embark on a program of materials research which is often conducted at least in part at the local plant. This can involve a significant research effort. It also stimulates a program of technological diffusion which can have a multiplier effect. The corporation has a direct incentive to develop a network of local suppliers and to assist them in their managerial and technical skills to assure a reliable supply of materials meeting quality standards.

Governmental regulations controlling the quality of products also stimulate the establishment of research facilities. In the pharmaceutical industry, quality control involves the application of professional skills in clinical testing. In the automotive industry, quality control can involve huge investments in testing grounds and testing equipment

1/ Howard Pack, "The Use of Labor Intensive Techniques in Kenyan Industry", Technology and Economics in International Development, Agency for International Development, May 1972.

and highly professional skills. The multimillion dollar testing facility of the General Motors Corporation at Sao Paulo, Brazil, compares favorably with similar facilities in the developed countries.

In short, there is wide scope for adaptive engineering in the production stage. The degree of sophistication brought to this by the multinational corporation is greatly influenced by local governmental policy, by the size of the market, and by the general level of technical competence within the country.

#### Adaptive Engineering in Product Design and Development

There are a number of examples of modifications of products to meet local requirements and market opportunities. This usually involves the application of familiar techniques, but may well encompass highly professional training and sophisticated skills. It normally takes place in countries that have made substantial technological progress. The National Cash Register Company, for example, has in production in Argentina a cash register which was designed and engineered in its plant in Argentina. The plant initially produced a cash register intended for a relatively restricted market of large-scale commercial enterprises, such as department stores. About 80 percent of the commercial establishments in Argentina are small family-operated enterprises that require a much simpler machine to store money and to perform simple arithmetic functions, such as addition of sales items and registering the amount of change due. The machine designed in Argentina is intended for this market. A similar machine is being designed in their Brazil plant, appropriate for a comparable market in that country.

In the pharmaceutical industry, adjustments to local conditions can take the form of product development, involving highly sophisticated work in chemical and pharmaceutical development, although not qualifying as industrial research as that term is used in the pharmaceutical industry. G.D. Searle Company, a company that produces ethical drugs, specialized medical instruments and other medical supplies, carries out product development in the laboratories of its plants in Mexico, Argentina, Brazil, Colombia, and Chile. In this case, the local plants have built on the technical capabilities which started with a

clinical testing program. As the laboratories gained in experience and in technical competence, they moved ahead into more sophisticated areas of experimental development.

Among the more imaginative programs in the area of product design are the basic multipurpose transportation vehicles recently displayed by the Ford Motor Company and the General Motors Corporation at the Transpo 72 Exposition at Dulles International Airport. These are simplified low-cost vehicles specially designed to meet the requirements of developing countries. Conventional cars produced for the developed countries are usually luxury items for a limited group in developing countries and are frequently ill-suited to local road conditions. The multipurpose transport vehicle, as developed by Ford and GMC, can be used as a pick-up truck for farm and light commercial use, can be converted into a minibus, or can be placed on jacks and used as a power source to operate a water pump, a saw, or a rice-husking machine.

The Ford vehicle was designed for the market in Southeast Asia. At a modest investment of \$700,000 a research and development program conducted in Australia designed a vehicle that can be made almost entirely from materials and with manufacturing facilities available in the region, apart from the motor which will come from the Ford plant in the United Kingdom.<sup>1/</sup> The market in Southeast Asia for this type of vehicle has become more attractive because of rising incomes in rural areas resulting from higher agricultural productivity arising from the Green Revolution. The imaginative approach of the Ford Motor Company in consolidating and developing this market is as innovative and significant as the changes in product design to reduce costs of manufacture. Specifically, the normal requirement by developing countries that within a limited period of time a fixed percentage of the components will be produced locally

<sup>1/</sup> William Bourke, "Basic Vehicle for Southeast Asia", Technology and Economics in International Development, Agency for International Development May 1972.

has been ingeniously finessed by Ford's devising an agreement with the participating countries that a component produced in one country, such as in Singapore, will count toward meeting the fixed percentage requirement of all of the other countries. This will serve to optimize efficient use of local materials and to bring down the cost of the vehicle.

The innovative feature of dividing production of components on a regional basis as a means of broadening the market and reducing costs is an example of the way in which the multilateral corporation can bring its special competence in the marketing area to bear on technological adaptation. However, the success of the program will depend on the cooperation of the Governments within the area in implementing the regional concept.

Another example of equipment designed to meet the specific requirements of the developing countries is the so-called DNT tractor of the Ford Motor Company. The DNT or Developing Nations Tractor is a low-cost, one-man tractor that is intended to replace the ox or the water buffalo as a source of power in rural areas of the developing countries where higher cost farm equipment is uneconomical. The DNT tractor has been tested in Jamaica and elsewhere and apparently has been well received from the technical point of view. However, the product is still in the stage of experimental development, with possibilities being explored in different countries for arranging for credit facilities and for dealer organizations to assure after-sale service and maintenance.

The remarkable advances in electronics and in chemistry have had widespread repercussions within the developing countries. However, it is difficult to identify particular developments which resulted from research directed toward unique requirements within developing countries. One such example is a versatile, low-cost, rugged communications system, capable of being operated on ordinary flash-light batteries, designed by an employee in the Public Safety Division of the Agency for International Development. The equipment was developed and is being produced by the Hallicrafter Company, a subsidiary of the Northrop Corporation, with a commercial sale in developing countries ranging between \$1 million and \$2 million a year, primarily for the use of police services. The

equipment is now also beginning to find a market with U.S. Government agencies operating in remote areas such as the U.S. Forestry Service and the Indian Health Service in Alaska.<sup>1/</sup>

### Innovative and Adaptive Industrial Research

As far as can be determined, there are only a few examples of innovative or adaptive industrial research, as that term is customarily used, performed by U.S. multinational corporations solely or primarily with reference to requirements in the developing countries. Industrial research is directed toward the conversion of human talent and available resources into products for which there is a commercial market. A limiting factor on research on problems peculiar to the developing areas is the lack of a sizeable market for a product that might be produced as a result of the research. At the same time, the multinational corporations are naturally interested in extending the market for products that result from their research as widely as possible. Therefore, the developing countries are often the beneficiaries of new industrial processes or new products which have world-wide application, even though these processes or products were not developed exclusively within the context of the developing countries.

Corporations concerned with the production and marketing of agricultural products intended for industrial or commercial purposes occasionally locate their research facilities within the area where the products grown. The United Fruit Company, for example, has its principal laboratory in Honduras with a staff of some twenty five scientists drawn from Latin America, the United States and Europe. The laboratory is concerned with plant genetics and plant pathology in

<sup>1/</sup> See "Multipurpose VHF-FM Tactical Transceivers OPS/FM-1B and OPS/FM-5B", Standard Specifications for Public Safety. Agency for International Development, February 1, 1968. See also Paul Katz, "New Multipurpose VHF/FM Equipment to Meet Internal Security Needs for Developing Countries", Law Enforcement Science and Technology, S.A. Yefsky, Editor, Vol. I Thompson Book Company, Academic Press 1967.

programs aimed at improving the production of bananas and palm oil. The Firestone Rubber Company which operates the largest rubber plantation in the world (80,000 acres) in Liberia maintains a laboratory in that country to work on problems relevant to rubber production. The laboratory has a staff of twenty-five scientists. Under a policy of training Liberians in the research area, almost thirty Liberians hold professional and technical positions in the management and research operations of the laboratory. Since the company is a leader in the field of rubber latex, its research programs are in the area of biology and plant genetics aimed at developing better producing and disease resistant rubber trees, and in the fields of chemistry and biochemistry aimed at developing better methods for preserving latex for shipment to industrial consumers around the world.

As a general rule, basic and applied research on problems of principal concern to the developing countries, to the extent that the multinational corporations perform such research, are performed by company laboratories located in the technologically advanced countries, where the long established research organization and facilities exist. Rubber companies, for example, with subsidiaries or affiliates in the developing countries, produce tires better suited to local climatic and road conditions than tires produced for home markets. The product design in such cases rests on research done in the United States, but the local factory depending on its capabilities may contribute its knowledge and skills to producing a product best suited to the particular country. Tires produced in Chile may therefore differ from those produced in Brazil or Argentina. In some cases, the local work on tire engineering and product development may extend to other forms of industrial research. The General Tire and Rubber Company, for example, has joint ventures with rubber companies in a number of countries in Latin America, including arrangements for technical assistance. In Argentina, its local affiliate FATE S.A.I.C.I. of Buenos Aires has built up an impressive research staff, and has recently entered into an arrangement with General Tire for a long-term cooperative program looking toward advanced research in chemistry, physics, and other scientific fields requiring the skilled services of chemists, mathematicians, engineers, aerodynamicists and astrophysicists.

It remains to be seen whether the General Tire and Rubber Company will find it practicable to have a portion of its industrial research program carried out in the laboratories in Argentina under this arrangement. However, the experiment points to the advanced scientific and technical capabilities of research institutions in Argentina.<sup>1/</sup>

The food processing industry has become increasingly involved in research aimed at developing low-cost high protein foods which would be of particular benefit to countries in the developing world whose populations suffer from malnutrition. At the same time, the products should be beneficial to low-income families in the developed countries. The programs have been stimulated by the attention focused on the nutritional problem in the developing countries by the Agency for International Development, and its modest program of grants initiated in the mid-1960's for market surveys in this area. However, the leading firms at present in this area have also devoted their own funds to research and development of such products. One of the better known high protein foodstuffs is the so-called Golden Macaroni, developed by the General Foods Corporation at its laboratories in Tarrytown and Battle Creek. The macaroni, made from wheat mixed with soy and corn, is about 20 percent less expensive than conventional macaroni and contains about seven times more protein. The product has been field tested and has had a successful market in institutions in the United States and in the developing countries, principally for school lunch programs. A subsidiary is producing the macaroni in Brazil for school programs and a Brazilian manufacturer has obtained a license to make the product for sale to other institutions in that country, such as the army and hospitals.

CPC International of New Jersey, generally referred to as Corn Products, has developed a product known as Duryea, designed for babies after weaning and before they start on a conventional diet. The product is based on the new breed of high lysine corn, developed at Purdue University, which has essential protein for babies

<sup>1/</sup> Enno Hobbing, "Impact of Private Foreign Investment on Latin America's Scientific and Technological Progress", Council of Americas, 1971.

at that critical period of their development. The product costs the equivalent of 13.8 cents for ten feedings, and is in production in Colombia where it has already extended to an estimated 40 percent of the potential market. Colombia was selected in part because of its success in introducing high lysine corn into production and because of the active interest of the Government in the nutritional requirements of its population. Plans are now being worked out to set up production in Brazil.

Another area that is being actively explored is a soft drink with a protein content. Quaker Oats has set up an international soft drink department and has taken over the experimental distribution of a product which had been initiated by Monsanto Chemical Company in Guyana. The drink called PUMA is similar to the VITASOY beverage which was an early form of soft drink with a protein content developed in Hong Kong. The drink appears to have reached almost 30 percent of the population of Guyana with sales running into the millions of bottles. The Coca Cola Corporation is working out the first soft drink of this type that fizzes. It is called TAI, and has an orange flavor. The technology in carbonating a soft drink with a protein content was difficult. The product is now being market tested in Africa. It costs a little less than a bottle of coca cola.

Other food programs are under active consideration, involving the marketing of a protein additive for manioc, the development of low-cost foods from the soy bean, the development of edible protein from cottonseed meal, and the like. The oil companies have worked out methods for developing edible protein from petroleum, but as yet they have not found a technology for producing this at low-cost .

The oil companies have been interested in supporting research involving pesticides and fertilizers. Standard Oil of New Jersey developed a spray at its Linden, New Jersey, laboratory to combat the banana fly. The Standard Oil Company of California's local chemical group worked with a Colombian rice research group to develop applications of one of their pesticides to save the Colombian rice crop from devastation by the white leaf disease. In this connection, the multinational corporations have played a significant role in helping to

bring the results of research, not necessarily conducted in their own laboratories, to practical application in the developing countries. Fertilizer corporations fulfilled a key function in connection with the Green Revolution in bringing to the farmers the new high yield seeds, plus the fertilizers and expert guidance in the appropriate inputs and other techniques required to bring the seeds to successful fruition.

Another example of research relevant to the needs of developing countries are the techniques developed by petrochemical companies for controlling desert encroachment, of particular interest to countries bordering the Sahara desert. The Standard Oil Company of New Jersey conducted experiments in its laboratories in the United Kingdom on sand dune behavior as simulated in a wind tunnel, and developed a system for spraying oil as a sealant with favorable results in Libya in preserving young trees against sand storms. Other similar programs have been developed by other companies, but high costs still constitute a deterrent to widespread applications of technologies produced thus far.<sup>1/</sup>

Although examples such as the foregoing could be multiplied, the fact remains that there appear to be only isolated examples of industrial research, properly so-called, being conducted by multinational corporations in the developing countries, and comparatively few examples of research conducted in their own laboratories which are specifically directed toward problems of primary concern to the developing areas of the world.

#### New Environment for International Development

Over the past decade there has been a significant change in the environment for international development. Developed countries, formerly preoccupied with their own problems of recovery from World War II, are embarked on major assistance programs for the benefit of developing countries, so that the U.S. program, although still the largest, is no longer dominant in this area. The U.N. organizations have gained in experience and expertise in their work with the developing countries. The work

<sup>1/</sup> Desert Encroachment on Arable Lands: Significance, Causes and Control, Office of Science and Technology, Agency for International Development, August, 1972.

of the donor countries, the multilateral financial institutions, the UN and other multilateral institutions, and the foundations have all contributed to substantial gains by the developing countries. As a result, the developing countries now have their own cadres of highly trained professional and technical personnel, and are showing a greater determination and ability to take charge of their own development programs. In consequence, the modes of operation of foreign assistance agencies give greater recognition to the developmental goals and priorities which the Governments of the developing countries are setting themselves.<sup>1/</sup>

The multinational corporations have played a significant role in helping to upgrade the managerial and technical skills which have contributed to the new international environment. The corporations are aware of the changes that have taken place, and many are seeking ways to respond to the concerns of the developing countries. Within some of the corporations this is being reflected in organizational changes. For example, the Dupont Company had been using the same staffs to handle all overseas operations. Now a reorganization is underway that will place under a separate staff the planning and development responsibilities for its products for the developing countries. This opens up greater possibilities for imaginative programs aimed at the markets in those countries and for greater sensitivity to the interest of those countries in strengthening their competence in the industrial research area.

If the multinational corporations are to play a greater role in supporting industrial research relevant to the requirements of the developing countries, other changes will probably be necessary. In the first place, market opportunities will need to be expanded for the products of such research. This will come about in due course as the developing countries achieve economic and social progress, and as incomes rise on a broader scale. There is scope, however, for developing countries to take measures at this time which will assure an adequate market for a given product or to work out cooperative regional arrangements to broaden and deepen such market opportunities. Secondly, reasonable inducements

<sup>1/</sup> President Nixon, For a Generation of Peaceful Development, Message to the Congress, April 21, 1971.

will be required to encourage corporations to undertake the relatively high-risk and relatively long-term investment involved in industrial research. Finally, the multinational corporations will need a different type of managerial talent involved in their operations in the developing countries. It is only rarely that the current executives of their plants in the developing countries have the capability for organizing and directing first-class research operations.

It is clear, therefore, that if the burden of developing research capabilities within the developing countries is left entirely to the private sector, progress will be made very slowly. If more rapid progress is to be made, the developing countries will have to take measures themselves to create market opportunities for the products of research and to develop more rapidly their own capabilities in science and technology. To this end they should devote more resources to research and development themselves, and they need to concentrate their resources within the framework of a coherent and appropriate science policy that is reflected in education and training as well as in research.<sup>1/</sup>

Significant progress can be made in the area of adaptive engineering by Governments through skillful economic policies buttressed by the creation of appropriate governmental institutions with technical competence in applied science and industrial technology.

The area of industrial research is more difficult since this depends not only upon the availability of talented people, who already exist within the developing countries, but upon the healthy growth of institutions which is complex and can take place even under a favorable climate only over a relatively long time span.

This is an area where the United States and other donor countries have much to offer. If the developing countries, with increased institutional strength and a coherent strategy for building up their own scientific and technological capabilities, offer the multinational

<sup>1/</sup> Report of the Commission on International Development to the President of the World Bank, Partners in Development, Praeger Publishers, 1969.

corporations adequate market opportunities and appropriate incentives for cooperative research programs, there is a good possibility that the unique strengths in the industrial research field of the multinational corporations could be brought to bear more widely and effectively on some of the critical and urgent problems facing the developing world.